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(71) Applicant: **Siemens Canada Limited**
Auburn Hills, Michigan 48326-2980 (US)

(72) Inventors:
- **Bolsover, Graham**
  Kingsville, Ontario N9Y 3Y9 (CA)
- **Whaley, Lisa**
  Wheatley, Ontario N0P 2P0 (CA)
- **Kehoe, Jon-David**
  Belle River, Ontario N0R 1A0 (CA)
- **Lee, Ki Ho**
  Windsor, Ontario N9G 2W3 (CA)

(74) Representative:
Humphrey-Evans, Edward John et al
Siemens Shared Services Limited,
I.P.D,
Siemens House,
Oldbury
Bracknell, Berkshire RG12 8FZ (GB)

(54) Fuel rail and injector assembly and method of forming a fuel rail

(57) A fuel rail (22) is formed by a lost core process. The core is formed of metal, and then over-molded with plastic. The plastic over-molded metal core is immersed in a hot bath of glycolitin oil. The metal core melts, leaving the plastic overmold fuel rail. Attachment features (35) can be formed in the fuel rail (22) to attach fuel injectors (26) by a snap fit connection (146), a threaded connection (242,244), or a twist and lock connection (342,364,376).

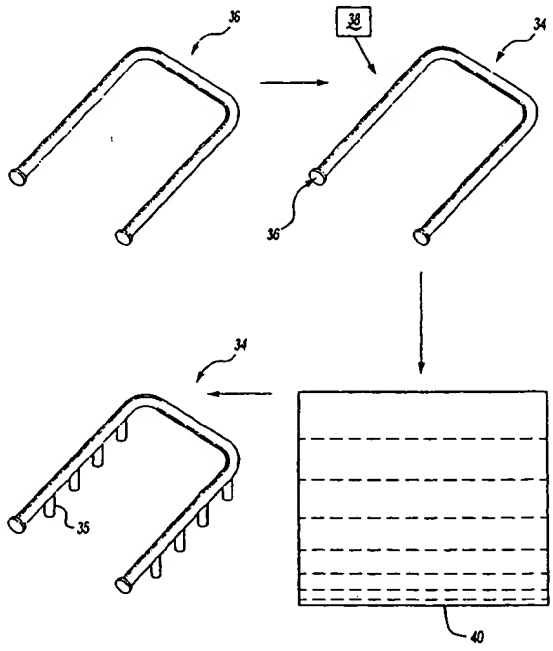


Fig-2

EP 1 201 916 A2

Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates generally to a fuel rail formed by a lost core process which is formed in one piece and includes attachment features for the attachment of fuel injectors to the fuel rail.

[0002] A fuel rail delivers fuel from the engine's fuel tank system and into an internal combustion engine. For a V-type internal combustion engine, it is common to form the fuel rail from two main fuel tubes. The fuel tubes are commonly made of metal or plastic and are either molded or are stamped and welded. The fuel tubes are connected by a metal cross-over tube which conveys fuel from one tube to the other. O-rings are used to seal the connection. The fuel rail also includes a plurality of sockets. Fuel injectors are inserted into the sockets to supply fuel to the internal combustion engine. The fuel injectors are secured to the sockets of the fuel rail by stamped metal clamps.

[0003] A drawback to the prior art fuel rail is that additional materials are needed for assembly. A cross-over tube and o-rings are needed to attach the fuel tubes, and stamped metal clamps are needed to secure the fuel injectors to the fuel tubes. These additional materials are costly and require additional time for assembly.

[0004] Hence, there is a need in the art for an improved fuel rail formed by a lost core process which is formed in one piece and includes attachment features for attachment of fuel injectors.

SUMMARY OF THE INVENTION

[0005] The present invention relates generally to a fuel rail formed by a lost core process which is formed in one piece and includes attachment features for attachment of fuel injectors.

[0006] The fuel rail of the present invention is formed by a lost core process. A metal core is formed and then over-molded with plastic. The plastic over-molded metal core is immersed in a hot bath, typically of glycolitin oil. As the melting temperature of the metal core is less than the melting temperature of the plastic overmold, the metal core melts, leaving the plastic overmold fuel rail.

[0007] As the fuel rail is formed by a lost core process, attachment features can be easily formed for attachment of fuel injectors to the fuel rail. In a first embodiment, the fuel rail includes a plurality of cylindrical sockets including an enlarged annular rim. Each fuel injector has a snap fit connector including a pair of inclined portions separated by a gap. A flat surface is formed by the inclined portions. The diameter of the flat surface is slightly larger than the inner diameter of the annular rim. When a snap-fit connector of the fuel injector is inserted into a cylindrical socket of the fuel rail, the inclined portions are slightly pressed together, eliminating the gap and reducing the diameter of the flat surface and allowing the inclined portions to pass through the annular rim. Once the inclined portions pass through the annular rim, the gap reforms, securing the fuel injector to the fuel rail.

[0008] Alternatively, a plurality of internal threads are molded on the inner surface of the cylindrical socket of the fuel rail. Each fuel injector includes a plurality of corresponding external threads which are threaded into the internal threads of the socket, securing the fuel injector to the fuel rail.

[0009] In a third embodiment, a groove is molded into the inner surface of a cylindrical socket of the fuel rail. The external surface of each of the fuel injectors includes a corresponding notch. When the fuel injector is positioned in the socket of the fuel rail, the notch engages the groove, and the fuel injector is secured in the fuel rail by a twist and lock connection.

[0010] Accordingly, the present invention provides a fuel rail formed by a lost core process which is formed in one piece and includes attachment features for attachment of fuel injectors.

[0011] These and other features of the present invention will be best understood from the following specification and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The various features and advantages of the invention will become apparent to those skilled in the art from the following detailed description of the currently preferred embodiment. The drawings that accompany the detailed description can be briefly described as follows:

Figure 1 illustrates a prior art fuel rail assembly;
Figure 2 illustrates a lost core process used to form a fuel rail;
Figure 3A illustrates a snap fit connection to connect a fuel injector to the fuel rail;
Figure 3B illustrates the snap fit connector in a flexed position;
Figure 4 illustrates a threaded connection to connect a fuel injector to the fuel rail; and
Figure 5 illustrates a twist lock connection to connect a fuel injector to the fuel rail.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0013] Figure 1 illustrates a prior art fuel rail assembly 20. The fuel rail assembly 20 includes a fuel rail 22 which is mounted to an air intake manifold 24. Fuel from the fuel rail 22 are injected by fuel injectors 26 into cylinders of the internal combustion engine 21. In the prior art fuel rail 22, the fuel rail 22 is formed of metal and is either molded or stamped and welded. The fuel rail 22 is secured to the air intake manifold 24 by screws 28 which pass through tabs 30 on the fuel rail 22. The screws 28 are received in posts 32 on the air intake manifold 24,

securing the fuel rail 22 to the air intake manifold 24.

[0014] The fuel rail 34 of the present invention is formed by a lost core process. As illustrated in Figure 2, a core 36 is first formed of metal, and then over-molded with plastic by a plastic injector 38 to form a plastic overmold fuel rail 34. The over-molded metal core 36 is then immersed in a hot bath 40, typically of glycolitin oil. As the melting temperature of the metal core 36 is less than the melting temperature of the plastic overmold fuel rail 24, the metal core 36 melts, leaving the plastic overmold fuel rail 34 which is capable of handling pressurized liquid fuel. As the fuel rail 34 is molded by a lost core process, attachment features 35, such as sockets, can be molded into the fuel rail 34 to provide for attachment of fuel injectors 26 to the fuel rail 34.

[0015] Figure 3A illustrates a fuel injector 126 attached to a fuel rail 134 by a snap fit connection. The fuel rail 134 includes a socket 142 with an annular rim 144 having an inner diameter A. The fuel injector 126 includes a snap fit connector 146 having pair of inclined portions 148A and 148B separated by a gap 150. A flat surface 152 is formed by the inclined portion 148A and 148B and has a non-flexed diameter B which is slightly larger than diameter A of the socket 142.

[0016] As shown in Figure 3B, when the snap fit connector 146 is inserted into the socket 142, the inclined portions 148A and 148B press together, eliminating gap 150. The flat surface 152 has a flexed diameter C, which is less than diameter A of the socket 142, and the flat surface 152 is able to pass through the annular rim 144. Once the inclined portions 148A and 148B pass through the annular rim 144, the inclined portions 148A and 148B separate, expanding gap 150. The gap 150 reforms and the flat surface 152 returns to having diameter B. As diameter B of the flat surface 152 is slightly larger than the diameter A of the annular rim 144, the inclined portions 148A and 148B of the snap fit connector 146 are secured in the socket 142, securing the fuel injectors 126 to the fuel rail 134.

[0017] Figure 4 illustrates a second embodiment of the fuel rail 234. The fuel rail 234 includes a plurality of sockets 242 each including a plurality of internal threads 244. Each fuel injector 226 includes a threaded portion 250 including a plurality of external threads 248. The external threads 248 of each fuel injectors 226 are threaded into the internal threads 244 of the sockets 242, securing the fuel injector 226 to the fuel rail 234.

[0018] Figure 5 illustrates a third embodiment of the fuel rail 334 using a twist and lock attachment feature. In this embodiment, the fuel rail 334 includes a plurality of sockets 342 each having a groove 364 on the interior surface 366. The groove 364 is substantially u-shaped and preferably includes a vertical portion 368, a perpendicular horizontal portion 370, and a locking vertical portion 372. The vertical portion 372 extends from the lower edge 374 of the socket 342.

[0019] A notch 376 is positioned on the fuel injector 326 proximate to the upper surface 378 of the fuel injector 326. When the fuel injector 326 is inserted into the fuel rail 334, the notch 376 inserts into the vertical portion 368 of the groove 364 at the lower edge 374. When the notch 376 has completed passing through the vertical portion 368 of the groove 364, the notch 376 then travels horizontally through the horizontal portion 370. The notch 376 then travels downwardly into the locking vertical portion 372. In this position, the fuel injector 326 is secured to the fuel rail 334. Alternatively, the notch 376 is on the socket 362, and the groove 364 is on the fuel injector 326.

[0020] There are several advantages to the lost core fuel rail of the present invention. For one, the fuel rail 34, 134, 234, 334 can be easily formed and does not have to be welded as in prior art. The fuel rail can be formed in one piece and does not require a metal crossover tube or O-rings. Fewer parts are needed, saving money as well as assembly time. Additionally, attachment features can be easily molded into the fuel rail for attachment of fuel injectors 26, 126, 226, 326.

[0021] Accordingly, the present invention provides a fuel rail formed by a lost core process which is formed in one piece and includes attachment features for attachment of fuel injectors.

[0022] The foregoing description is only exemplary of the principles of the invention. Many modifications and variations of the present invention are possible in light of the above teachings. The preferred embodiments of this invention have been disclosed, however, so that one of ordinary skill in the art would recognize that certain modifications would come within the scope of this invention. It is, therefore, to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specially described. For that reason the following claims should be studied to determine the true scope and content of this invention.

Claims

1. A fuel assembly comprising:

   a fuel conduit formed by a lost core molding process including at least one opening; and

   at least one fuel injector including an attachment feature, said attachment feature of said at least one fuel injector being secured in one of said at least one opening.

2. The fuel assembly as recited in claim 1 wherein said attachment feature has a non-flexed dimension greater than an inner diameter of said at least one opening and a flexed dimension smaller than said inner diameter of said opening.

3. The fuel assembly as recited in claim 2 wherein said attachment feature has said flexed dimension when said at least one attachment feature is being insert-

ed into said opening, and said at least one attachment feature has said non-flexed dimension after said at least one attachment feature is inserted into said at least one opening.

4. The fuel assembly as recited in claim 1 wherein said attachment feature of said fuel injector is a plurality of external threads which engage a plurality of internal threads on a wall of said at least one opening of said fuel conduit.

5. The fuel assembly as recited in claim 1 wherein said attachment feature of said fuel injector is one of a notch and a groove which engages the other of said notch and said groove on a wall of said at least one opening of said fuel conduit.

6. The fuel assembly as recited in claim 5 wherein said attachment feature of said fuel injector is said notch and said groove is on said wall of said at least one opening of said fuel conduit.

7. The fuel assembly as recited in claim 6 wherein said groove is substantially u-shaped and includes a first portion extending from a lower edge of said opening, a second portion extending substantially perpendicularly to said first portion, and a third portion extending substantially parallel to said first portion, said notch being received in said third portion of said groove to secure said at least one fuel injector to one of said at least one opening of said fuel conduit.

8. A fuel assembly comprising:

a fuel conduit formed by a lost core molding process including at least one opening to provide fuel to an engine component; and
at least one fuel injector including an attachment feature, said attachment feature of said at least one fuel injector being secured in one of said at least one opening; and
said engine component.

9. The fuel assembly as recited in claim 8 wherein said attachment feature has a non-flexed dimension greater than an inner diameter of said at least one opening and a flexed dimension smaller than said inner diameter of said opening.

10. The fuel assembly as recited in claim 9 wherein said attachment feature has said flexed dimension when said at least one attachment feature is being inserted into said opening, and said at least one attachment feature has said non-flexed dimension after said at least one attachment feature is inserted into said at least one opening.

11. The fuel assembly as recited in claim 8 wherein said attachment feature of said fuel injector is a plurality of external threads which engage a plurality of internal threads on a wall of said at least one opening of said fuel conduit.

12. The fuel assembly as recited in claim 8 wherein said attachment feature of said fuel injector is one of a notch and a groove which engages the other of said notch and said groove on a wall of said at least one opening of said fuel conduit.

13. The fuel assembly as recited in claim 12 wherein said attachment feature of said fuel injector is said notch and said groove is on said wall of said at least one opening of said fuel conduit.

14. The fuel assembly as recited in claim 13 wherein said groove is substantially u-shaped and includes a first portion extending from a lower edge of said opening, a second portion extending substantially perpendicularly to said first portion, and a third portion extending substantially parallel to said first portion, said notch being received in said third portion of said groove to secure said at least one fuel injector to one of said at least one opening of said fuel conduit.

15. A method for forming a fuel assembly by a lost core molding process comprising the steps of:

forming an inner core made of metal;
overmolding said metal core with a plastic overcoat; and
melting said inner metal core.

16. The method as recited in claim 15 wherein the step of melting said metal core includes placing said metal core and said overcoat in glycolitin oil.

17. The method as recited in claim 15 further comprising the step of forming at least one opening in said plastic overcoat to receive a fuel injector having an attachment feature.

18. The method as recited in claim 17, wherein a fuel injector is attached to said attachment feature.

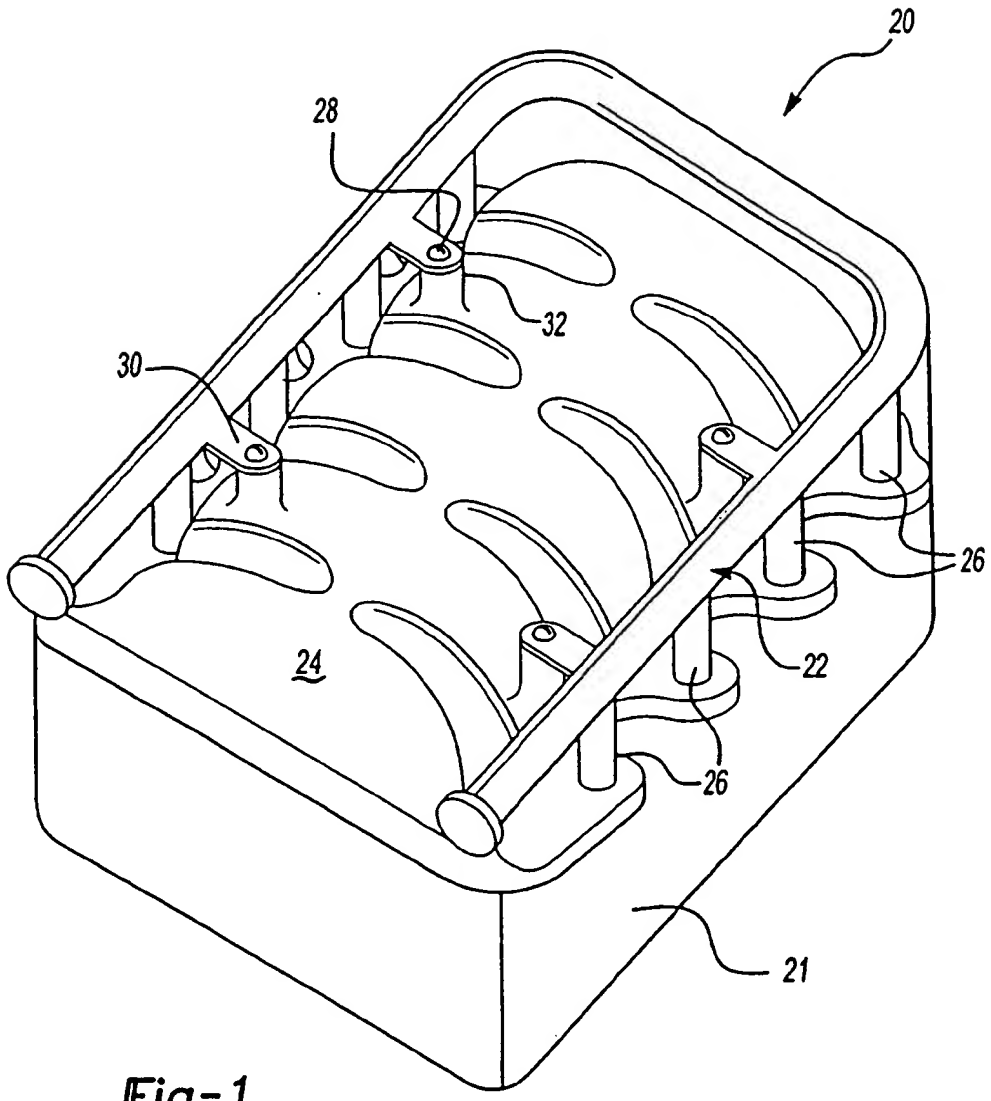


Fig-1
PRIOR ART

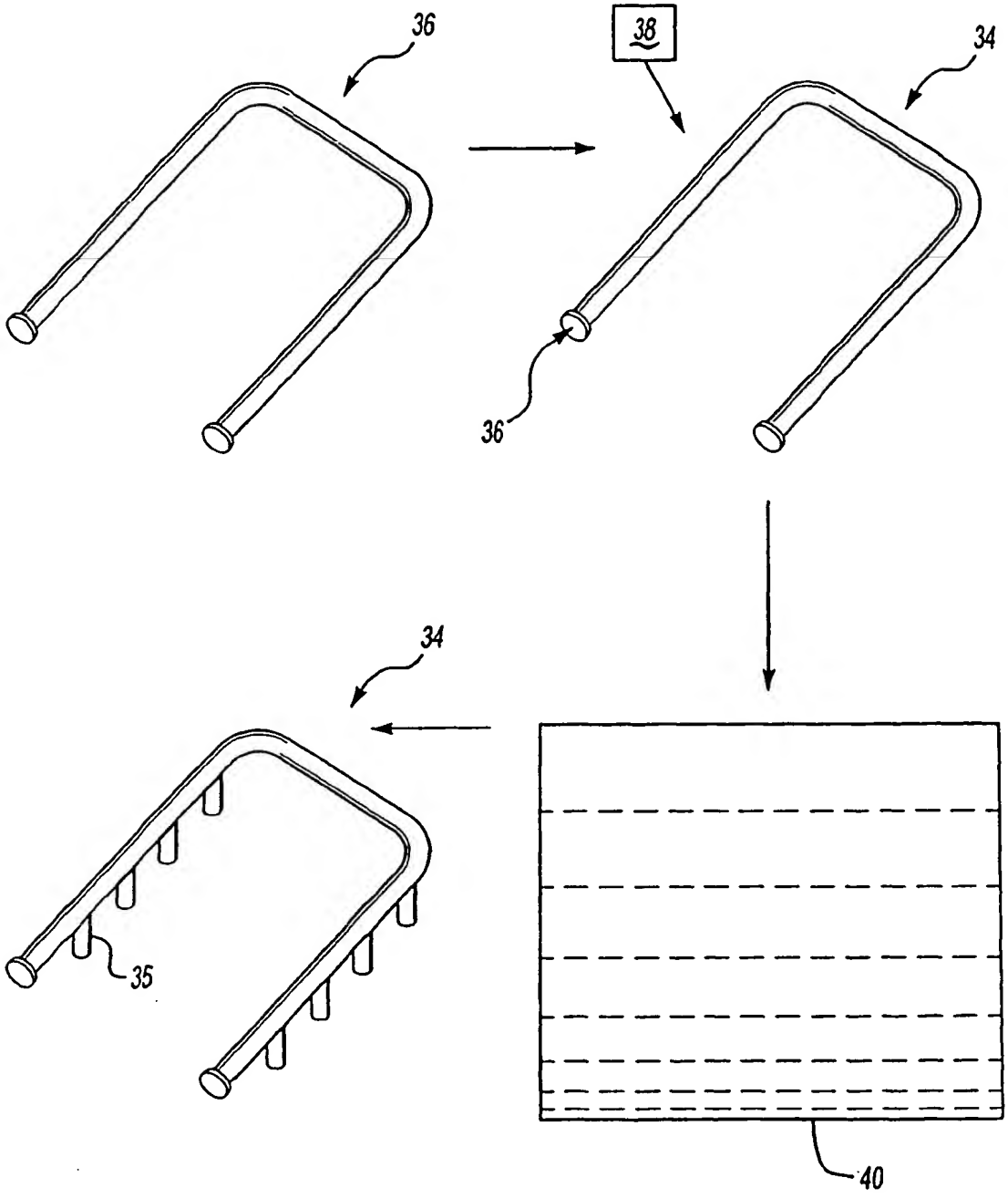


Fig-2

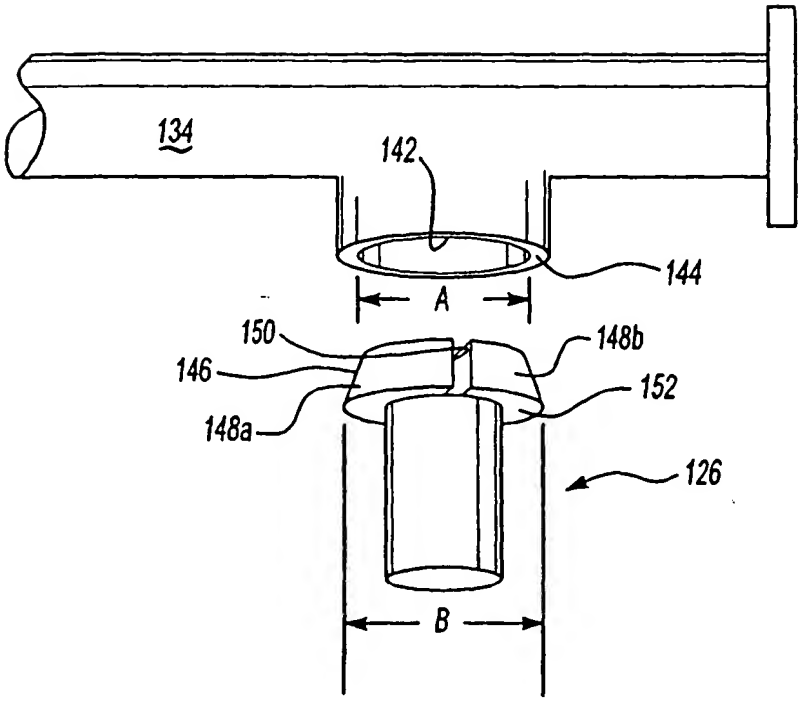
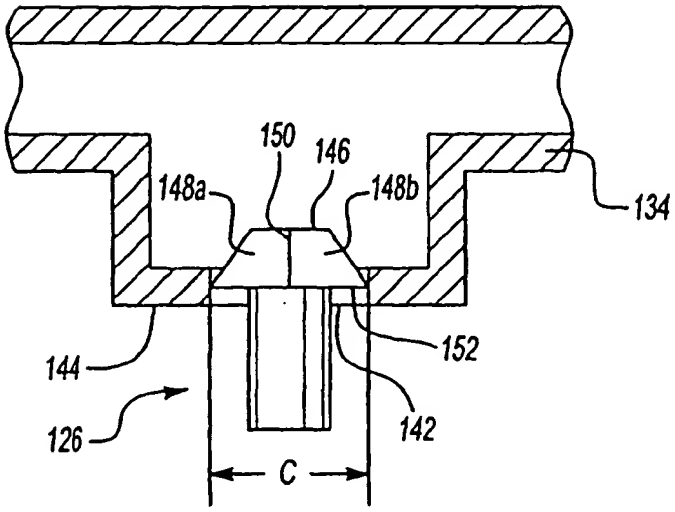

134
142
144
A
150
148b
146
152
148a
126
B

Fig-3A


150
146
148a
148b
134
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152
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142
C

Fig-3B

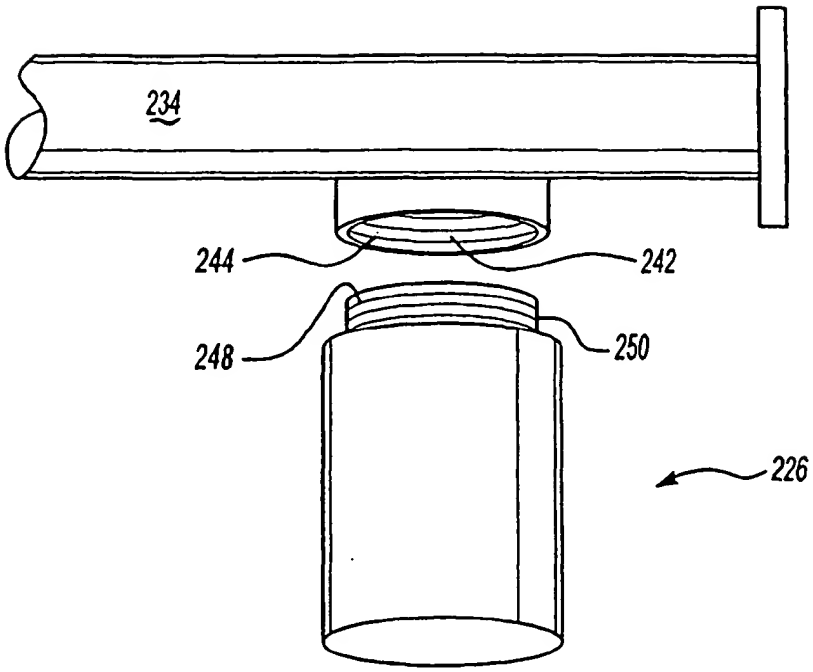
234
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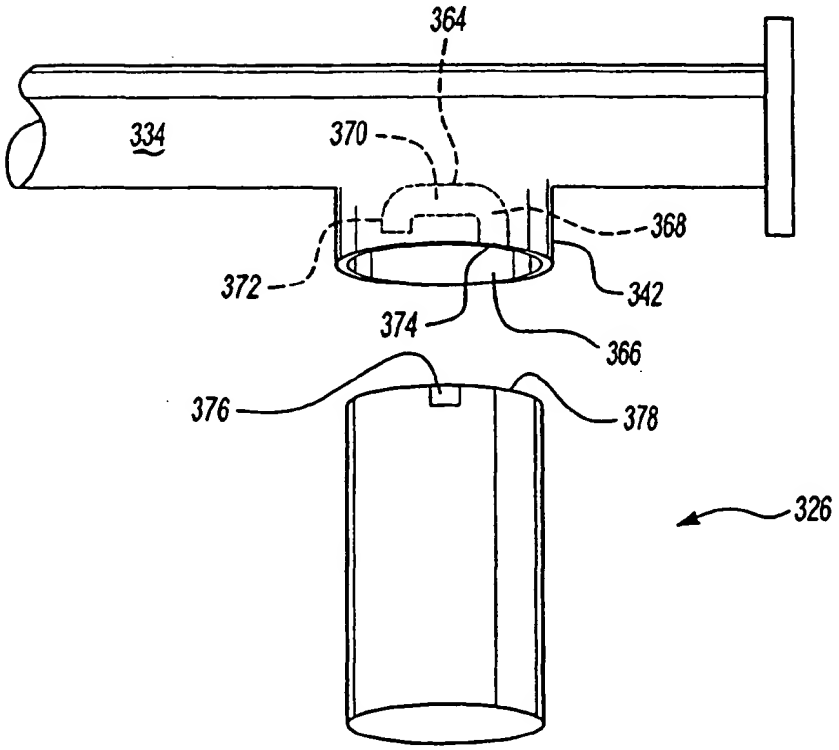
Fig-4


364
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372
342
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326

Fig-5

(19) Europäisches Patentamt
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(71) Applicant: **Siemens Canada Limited**
Auburn Hills, Michigan 48326-2980 (US)

(72) Inventors:
- **Bolsover, Graham**
  Kingsville, Ontario N9Y 3Y9 (CA)
- **Whaley, Lisa**
  Wheatley, Ontario N0P 2P0 (CA)
- **Kehoe, Jon-David**
  Belle River, Ontario N0R 1A0 (CA)
- **Lee, Ki Ho**
  Windsor, Ontario N9G 2W3 (CA)

(74) Representative: **French, Clive Harry et al**
Siemens AG,
PO Box 22 16 34
80506 München (DE)

(54) Fuel rail and injector assembly and method of forming a fuel rail

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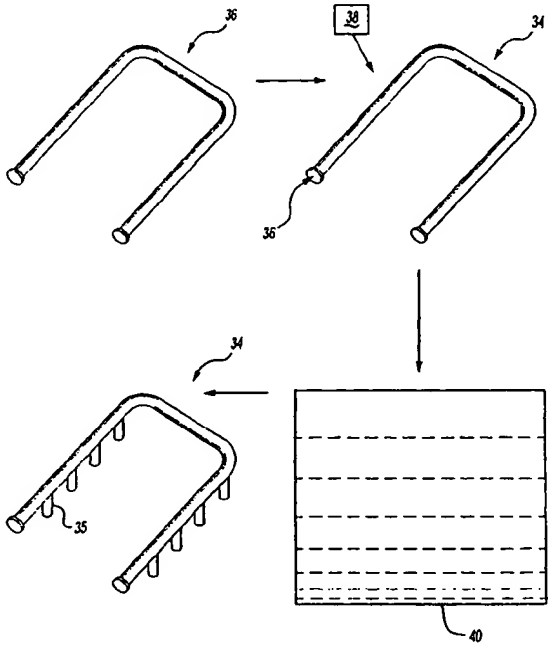

Fig-2

EP 1 201 916 A3

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EUROPEAN SEARCH REPORT

Application Number
EP 01 20 3669

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 4 395 988 A (KNAPP HEINRICH ET AL) 2 August 1983 (1983-08-02) * column 3, line 44 - column 4, line 15 *	1-3,8-10	F02M55/02 F02M69/46
X	US 5 140 963 A (COLE LLOYD ET AL) 25 August 1992 (1992-08-25) * column 4, line 40 - line 44 * * column 3, line 40 - line 60 *	1,5,6,8, 12,13	
X	US 5 301 647 A (LORRAINE JACK R) 12 April 1994 (1994-04-12) * column 2, line 59 - column 3, line 15; figure 3 *	1-3,8-10	
X	US 4 991 557 A (DEGRACE LOUIS G ET AL) 12 February 1991 (1991-02-12) * column 2, line 24 - column 2, line 58; figures 1,2 *	1,8	
X	US 5 724 946 A (FRANCHITTO ANTHONY LOUIS) 10 March 1998 (1998-03-10) * column 3, line 35 - line 38; figure 7 *	1,5,6,8, 12,13	TECHNICAL FIELDS SEARCHED (Int.Cl.7) F02M
A	US 5 531 202 A (LORRAINE JACK R) 2 July 1996 (1996-07-02) * column 3, line 43 - line 51 *	1-3,8-10	

~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
THE HAGUE	27 February 2002	Nobre, S

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

European Patent Office

Application Number
EP 01 20 3669

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-14

European Patent Office

LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 01 20 3669

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. Claims: 1-14

   Fuel assembly comprising an injector with an attachment feature secured in at least one opening of a fuel conduit

2. Claims: 15-18

   method for forming a fuel assembly by a lost core molding process

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 01 20 3669

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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27-02-2002

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